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ABSTRACT

The teaching of decision-making, problem-solving, and higher-order thinking skills is necessary to ensure adaptability to our world of accelerated change. Living skills in the technology and information age will include the understanding and application of higher level thinking skills, which will be the educational "basics" of tomorrow. Although there are diverse opinions regarding what constitutes higher-order thinking skills, they include the development of higher cognitive levels (Piaget); the intellectual processes, that is, problem-solving, decision-making, synthesizing (Bloom); and intellectual activity, such as cognition and memory (Guilford). Teaching behaviors that seem to be important in developing thinking processes are teaching the basics of problem solving and asking difficult questions. Cultural and cognitive differences among learners influence which skills are taught and how they should be presented. Rather than preserve fact-oriented instruction, teachers can require analysis, synthesis, and evaluation of information using techniques such as a directed reading-thinking activity and inquiry learning, and materials such as the QUEST (Questions to Upgrade and Encourage Student Thinking) Program and the CoRT (Cognitive Research Trust) Program. It is evident the educational evaluation needs to focus more on process assessment and less on product assessment. In this future-oriented society, teaching the learner to think as well as think-about-thinking will need to be considered a priority goal in the public curriculum. A five-page list of references concludes this document. (LL2)

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THINKING ABOUT THINKING

Sarah J. Parker

CS 008 465

"All the school can or need do for pupils, so far as their minds are concerned, is to develop their ability to think."

John Dewey (1916)

Because our world is faced with accelerating change, a major goal in education should be to develop the learner's capacity to adapt to change using decision making, problem solving and other higher-order thinking processes which will enable him/her to engage in lifelong learning. Facilitating this process involves some higher-order thinking on the part of educators. Knowledge and understanding of thinking skills will involve inquiry and analysis of existing research, theory, and methods. Evaluation concerning the values of thinking skill materials and methods may then lead to appropriate selection of processes and procedures which are applicable to the school curriculum. Once a set of methods and materials are selected, synthesis of the knowledge may lead to effective application. As illustrated above, it is evident that thinking about thinking involves a complex decision-making process which requires educators to select relevant objectives, processes, and methods for teaching higher-order thinking skills.

The nature of this paper is to present a global review of research, theory, and methods relating to the teaching of higher-order thinking skills. Its purpose is to provide a conceptual framework for school administrators, curriculum coordinators, classroom teachers, and other educators who recognize the need to facilitate students' development of higher-order thinking skills. Following is a comprehensive discussion of future living skills;

higher-order thinking skills and how they are perceived by a variety of sources; reasons for teaching thinking skills; methods for teaching thinking; evaluating the higher-order skills; and implementing thinking skill instruction.

Future Living Skills

Rapidly expanding technology and the information age require people to engage in self-directed lifelong learning. Rapid change "means that you cannot expect to remain in the same job or profession for life, even if it is an information occupation. The coming changes will force us to seek retraining again and again" (Naisbitt, 1982, p. 37). No longer can general knowledge and basic skills supply persons with adequate tools for productive living. "Without lifelong learning, one's skills will become rapidly dated" (National Commission on Excellence in Education, 1983, p. 3).

The information age also produces change in economic orientation. As Naisbitt (1982) expresses it, "we are working ourselves out of the manufacturing business and into the thinking business" (p.17). High technology and the information age pervade society and demand skills in brainpower. "We are now a nation of information workers" (Naisbitt, 1982, p. 21). For example, Naisbitt (1982) cites that "only 5 percent of the almost 20 million new jobs created in the 1970s were in manufacturing (almost 90 percent were in information, knowledge, or service jobs)" (p 21). Information production, processing, and distribution, along with mass-produced knowledge place increased demands on educational curriculum. "The more knowledge there is the more obvious it becomes that our task is not to make people into walking encyclopedias. We must try to teach

them to think" (Rickman, 1981). This view is shared by numerous sources (i.e. Bronson, 1975; The Education Commission of the States, 1982; Greene, 1983; Kierstead, Bowman, Dede, 1979; National Institute of Education, 1980; President's Commission for a National Agenda for the Eighties, 1980) advocating the belief that future living and employment skills require schools to facilitate improved instruction in higher-order intellectual abilities. These sources may further agree that many of these higher-order skills, at present, are not sufficiently displayed by students. "In addition to mere mastery of the basics of today, schools must teach students the understanding and application of higher level skills, the basics of tomorrow" (The Education Commission of the States, 1982, p. 24). To accommodate these "new basics" for future living, education should continually study social and economic trends and their educational implications. Since education generally reflects rather than shapes changes in society, accelerating technological changes and the information age are realities needing direct analysis and consideration by professional educators. In this context, it is evident then that the development of higher-order thinking skills reflects societal change and can provide students with relevant skills for future living.

Higher-Order Thinking Skills

What are the higher-order thinking skills? There are diverse opinions concerning the concept of thinking skills. Some educators equate the concept of higher-order thinking skills with intelligence and ask themselves if intelligence can be taught. In fact, "many psychologists now regard intelligence as a set of information processing abilities that can be

diagnosed and taught" (Sternberg, 1981, p. 18).

Other theorists perceive that "teaching thinking" guides students towards higher levels of cognitive development. For example, Piaget, a developmental psychologist, encourages relating methods and materials to students' age and stage of cognitive development. This has significant implications for "teaching thinking". In essence, educators should attempt to understand the differing cognitive levels of students and how they relate to thinking skill instruction. "This calls for educators to be students of developmental psychology; to recognize the real attainments and limitations that define each stage of intellectual growth" (Jacob, 1982, pp. 231-232). Not only must educators be aware of their students' cognitive levels of development, but some may be interested in teaching for attainment of the higher cognitive levels. For instance, "statistics show that typically 50 to 75 percent of college freshman are not able to cope with the kinds of problems associated with the (Piaget's) formal operational stage" (Bauman, Wdowiak, & Loomis, 1979, p. 267). To guide college students' cognitive development, Bauman et. al. (1979) and Arons (1979) have attempted to devise ways of enhancing formal reasoning skills. In addition, "during the past five years a variety of cognitive programs have been started in colleges across the country. Many are based on the developmental theory of Piaget and are oriented to preparing students for the kinds of abstract reasoning expected in college" (Lockhead, 1979, p. 2).

Other ways to perceive higher-order thinking skills focus on developing intellectual processes such as problem solving, decision making, synthesizing, evaluating, and others. These processes can be conceptualized

using Benjamin Bloom's Cognitive Domain of the Taxonomy of Educational Objectives (Bloom, 1956). Behaviors in this cognitive domain range from performing simple cognitive recall tasks to synthesizing bodies of learned information and making evaluative judgements. Higher-order skills are those found at the higher levels of Bloom's Cognitive Domain. A very condensed version of Bloom's Taxonomy: The Cognitive Domain follows:

1. Knowledge - Involves recall and memory of specifics and universals, methods and processes, pattern, structures, or setting.
2. Comprehension - Represents the lowest level of understanding. It involves translating, interpreting, and/or extrapolating information or ideas without necessarily relating it to other material or seeing its fullest implications.
3. Application - Involves the use of abstractions in particular and concrete situations (memory and application of principles, ideas, and theories.
4. Analysis - Analysis of elements, relationships, and organizational principles involves the breakdown of ideas into parts for examination of relative hierarchies and relationships.
5. Synthesis - Involves the process of putting together of elements and parts as to form a whole.
6. Evaluation - Involves qualitative judgements about the value of material and methods for given purposes.

(Adapted from Bloom, 1956, pp. 201-207).

Other taxonomies are available. For example, Guilford has outlined five levels of intellectual activity: cognition, memory, convergent and divergent production, and evaluation (Artley, 1972). Norris M. Sander developed a taxonomy of classroom questions namely, memory, translation,

interpretation, application, analysis, synthesis, and evaluation (Sander, 1966). Many other taxonomies of cognitive levels of thinking exist and are effective if used with the intent of developing higher levels of cognitive thinking along with the basic levels such as knowledge, recall, and memory.

Most of the higher-order thinking skills mentioned in this paper are derived from Bloom's Taxonomy. Those that are not directly stated by Bloom's Taxonomy can be inferred from the cognitive levels in the domain.

Following is a list of higher-order thinking skills to which frequent reference will be made throughout this paper:

- Problem solving (some involving hypotheses)
- Decision making (given complex situations)
- Critical thinking
- Application, Analysis, Synthesis, and Evaluation
- Mediating
- Organization and reference skills (for lifelong learning)
- Logical reasoning (inductive, deductive)
- Inquiry and Discovery Learning
- Divergent thinking
- Information processing (Data input, Data processing, Data output)
- Interpreting
- Making inferences
- Drawing conclusions
- and others.....

Why Teach Thinking?

Many educators assume that students will learn to think merely by going to school (Maeroff, 1981). They may value the higher-order thinking

skills yet take for granted that they can be developed through the traditional curriculum (Hartmen-Haas, 1981). These assumptions may prove to be counterproductive. For example, The National Assessment of Educational Progress (NAEP) surveys the knowledge, skills, and attitudes of the nation's 17-year-old students. These NAEP results indicate that the higher-order thinking skills are achieved only by a minority of 17-year-olds (The Education Commission of the States, 1982).

Perhaps, too many "assumptions" have lead to this lack of ability in higher thinking skills. Similarly, The National Commission on Excellence in Education (1983) states that "schools may emphasize such rudiments as reading and computation at the expense of other essential skills such as comprehension, analysis, solving problems, and drawing conclusions" (p. 3). The Commission (1983) further states that "many 17-year-olds do not possess the 'higher order' intellectual skills we should expect of them. Nearly 40 percent cannot draw inferences from written material; only on-fifth can write a persuasive essay; and only one-third can solve a mathematics problem requiring several steps" (p. 3). Much of what is taught reinforces literal level knowledge and understanding while overlooking the higher-order intellectual processes. In a recent article published by Kappa Delta Pi, John Goodlad (1983) reviews his findings from "A Study of Schooling" which sought to gain insight into education through intensive and lengthy study of over 1,000 classrooms. Goodlad and his researchers noted a "marked discrepancy" between the curriculum expectations and the actual teaching practices and learning activities observed. Goodlad states, "Are the admittedly idealistic goals

we reviewed merely window-dressing, with the real purposes of schools being to teach a limited array of intellectual skills and facts extracted from the subject matter disciplines?" (Goodlad, 1983, p. 68). Further findings of Goodlad's study reveal that:

In effect, then at all levels - somewhat less in elementary schools than in high schools - lecturing, telling, questioning, quizzing, reading textbooks, and doing workbook exercises constituted the prevailing picture presented to the observer. Those activities which we tend to associate most with solving problems - independent inquiry, cooperation, creative expression, and the like - appear to be provided sparingly or hardly at all in many of the classrooms we observed. Students were seeking 'right' answers to specific questions; reading short passages and writing short statements, usually in response to questions already posed; and giving short answers or merely checking answers on quizzes and tests. Students usually worked alone in groups. Rarely were they called upon to engage in activities calling for collaborative action and, ultimately, they were provided rewards only if the entire group effort was deemed to be successful. Behaviors and traits being emphasized and reinforced appear to reflect only a very small fraction of those implied in state and district goals (Goodlad, 1983, pp.63-64).

These findings indicate the need for not only valuing higher-order thinking skills by goal-stating, but also insuring that methods for teaching them are improved.

Often in curriculum design and classroom teaching more emphasis is placed on the knowledge product and not the process by which the product is

attained. There is significant agreement among scholars on the product vs. process curriculum orientation. Many sources (Bloom, Broder, 1950; Costa, 1981; Dewey, 1910; Greenfield, 1979; Kaput, 1979; Lockhead, 1979; Sternberg, 1981) express the overemphasis on products and the need to value and develop thinking processes. This orientation has significant implications for the school curriculum, classroom teaching, and various forms of testing. Educational goals should attempt to direct the instructional emphasis towards the development of higher-order thinking processes as well as the attainment of specific knowledge products.

Due to a wide variety of definitions, methods, theories, and instructional materials relating to the teaching of higher-order thinking skills, research is somewhat diverse on the topic. Bauman et. al. (1979) investigated whether the level of intellectual functioning of college students could be changed as a result of classroom teaching in specific thought processes. With pre-test and posttest ACT scores comparing a control group with an experimental group receiving a PH 10 course that teaches higher-order cognitive processes, results indicated that most students in the experimental group showed a gain of at least one step (Piaget's concrete to transitional or transitional to formal stage of cognitive development). Furthermore, significance was established for the composite, English, and Natural Sciences subtests of the ACT taken by subjects in the experimental group. Overall, four teaching behaviors appear to be particularly important: teaching the basics of problem solving, encouraging strong intellectual involvement in the learning process, asking difficult questions, and facilitating student success on every problem (Bauman, et. al., 1979).

Narrol, Silverman, and Waksman's study (1982) "was designed to examine the effectiveness of Feuerstein's Instrumental Enrichment program in improving the cognitive performance of educationally retarded adolescents in vocational secondary schools" (p. 107). In a one-year study, specially trained teachers used the instrumental enrichment program involving skills for improved cognitive development with five experimental groups. "Pre-post test analysis revealed significant effects of the FIE (Feuerstein's Instrumental Enrichment) program on the cognitive performance of the experimental class students when compared with controls" (Narrol et. al., 1982, p. 107).

Another study based on the effectiveness of a focused program for teaching higher-order thinking skills was conducted by Edwards and Baldauf (1983). This study involved the use of "de Bono's CoRT Thinking Skills (Cognitive Research Trust, 1973) with a number of grade-ten secondary science classes" (Edwards & Baldauf, 1983, 1983, p. 129). Results indicated that of the four classes studied, inter-group differences were not significant (F ratio); results from pre-post test analysis were statistically significant; there is little or no relationship between I.Q. and development of CoRT Thinking Skills; and that students learned some generalizable skills from the CoRT program (Edwards & Baldauf, 1983). In summary, as evidenced by current theory and research aforementioned, it is valid to believe that educators should value and attempt to effectively teach higher-order thinking skills.

Teaching Higher-Order Thinking

Learner characteristics. When teaching the higher-order thinking skills to students, educators must be aware of the differences in cognitive

development (previously discussed) and culture. Carroll Quigley (1975) has cited a variety of cognitive differences that often exist between groups/cultures in society: Differences in time orientation, value systems, division of life-span, age-group classifications, and cognitive thinking and reasoning processes. In brief, cultural and cognitive differences introduce factors which influence what thinking skills are taught and how they should be presented.

The professional educator also needs to consider "today's learner". The information age and high technology society are creating many learners who are motivated by video games, computers, and television. "Television has, by its power to control the time, attention, and cognitive habits of our youths, inevitably gained the power to control their minds and character. The T.V. curriculum is easy. Watching television requires no skills and develops no skills" (Postman, 1983). Computers, video games, and "television stress instantcy, not constancy; discontinuity, not coherence; immediate, not deferred, gratification; emotional, not intellectual response" (Postman, 1983). Postman (1983) further discusses that on the average, students spend more time watching television than they do at school. In essence, the television curriculum and the school curriculum are competing "a competition the schools are losing" (Postman, 1983). Presently, evidence of this "loss" is apparent in many of the cognitive behaviors of young learners. Television is an intellectually passive activity and higher-order cognitive processes are intellectually active. Consequently, engaging students in the development of higher-order (active) thinking skills is a necessary, but difficult task. In addition, with technology allowing students to acquire basic factual information more readily, it will be necessary to teach processing skills

rather than facts. "Class sessions will become places where students and teachers order, sift, synthesize, and evaluate information" (Cichelli & Mulkeen, 1982). To sum up, culture and a changing society create differing needs and learner characteristics. To teach thinking skills effectively, professional educators cannot enter the challenge blindly. They must assess the changing needs of society and students in order to implement a relevant and effective thinking skill program.

Improvement of instruction. "We should be teaching students how to think; instead we are primarily teaching them what to think" (Lockhead, 1979, p. 1). Specific teaching behaviors can be developed which reinforce, encourage, and reward the use of higher-order thinking skills. Initially, intelligent behaviours should be valued as a goal of education (Costa, 1983). Not only should it be stated in the school's curriculum, but its value should be recognized and displayed in the forms of instructional materials, in-service staff development on teaching the higher-order processes, assessment devices, instructional time devoted to teaching thinking, student and teacher discussion concerning thinking, reward and reinforcement of higher-order thinking displayed by students, and adult-modeling of intelligent behaviors. In effect, valuing the higher-order processes in the above ways indicates to students that they are an important educational goal.

Teacher Questioning and Higher-Order Thinking

Teachers can lead students into differing levels of thinking through careful use of classroom questions. Using the basic structure of Bloom's Taxonomy of Educational Objectives, teachers can begin to conceptualize differing cognitive levels and how questions can be formed to elicit

responses that go beyond the levels of Knowledge and Understanding (see Bloom's Taxonomy, a condensed version, page 5 of this paper). This type of questioning method can be used with oral or written questions, teacher questions, student questions, textbook questions, assessment questions, or those from other sources. The goal of improving classroom questions is to encourage more than the overemphasized factual or literal recall of content by eliciting questions that guide students towards thinking and using higher-order cognitive processes.

Evidently, the questioning process is a significant part of the school day. Sarason reviewed a few research studies on the questioning process and found that elementary teachers believed that they "averaged between 12 and 20 questions per half hour, the actual number ranged between 45 and 150" (Shiman & Nash, 1974, p. 246). Furthermore, the types of questions asked by teachers are typically low-level fact and detail questions requiring students to respond using simple knowledge or understanding and not processes of application, analysis synthesis, or evaluation. Guszak (1967) observed and recorded reading comprehension questions asked by 106 second, fourth, and sixth grade teachers. Guszak (1967) found that "teachers spent the greatest portion of their questions on the literal comprehension realms of 'recall' and 'recognition'. Seemingly, the observations tend to support the contention that elementary teachers dwell on literal comprehension" (p. 230). Guszak further concluded that "in real life reading situations, readers seldom approach reading with the purpose of trying to commit all the minute facts to memory" (p. 233). In a similar study, Davis and Tinsley (1967) observed student teachers

in a secondary school environment and classified the levels of questions they asked. Eight categories, similar to Bloom's Taxonomy, were used to judge the levels of questions asked by the student teachers. In this study, it was found that "the higher cognitive processes were seldom noted overall and, when observed, were evidenced by only a few of the teachers and their pupils" (Davis and Tinsley, 1967, p. 23). In brief, it is evident that the majority of classroom questioning processes are lacking in that they do not encourage higher-order thinking skills. It may be that teachers simply do not understand both the need to improve their classroom questions and how to make them more effective. Other reasons may be that factual questions are easier to measure, they supposedly maintain classroom order, and perhaps cover up teachers' own insecurities (Shiman & Nash, 1974). Shiman (1974) further believes that the danger of continually falling back on the certainty of factual questions is that we abandon opportunities to learn from our students.

Davidson (1970) went beyond the task of analyzing types of questions asked by teachers and studied a Directed Reading-Thinking Activity (DR-TA) involving higher-order questions asked by the teacher while students were engaged in a reading lesson. Davidson found that students' responses to the higher-order questions incorporated by the DR-TA were at levels higher than that of literal thinking. Students were, in fact, using higher-order thinking processes when asked interpretive and inferential questions. In a similar study, Hughes (1981) evaluated teacher and student behaviors when using a program called QUEST (Questions to Upgrade and Encourage Student Thinking). It was found that students of participating teachers varied significantly from students in the control group in that they

"asked more questions above the literal level (p .001); gave more complex responses (p .05); and more frequently supported inferences by citing evidence from experiences, generalizations, or authorities (p .025)." To sum up, it is necessary for classroom teachers to improve the quality of questions asked so that varying levels of cognitive thinking processes are encouraged in students' responses.

Figure 1 displays Part A of a chart developed by Gary Manson and Ambrose Clegg, Jr. (1970, pp. 304-305) which can be used as an aid for improving classroom questioning processes (keep in mind that Bloom's Taxonomy is only one device used for classification of cognitive abilities- See section titled, "Higher-Order Thinking Skills" in this paper):

Insert Figure 1 about here

Methods of Teaching Thinking Skills

Just as there are diverse definitions for the higher-order thinking skills, there also exist a wide variety of methods for teaching them. Many methods are derived from various theories, and are used in conjunction with existing classroom teaching and discussion techniques. Others, particularly many commercial materials, are designed for instruction that is specifically dedicated to teaching thinking skills.

The following examples of methods and approaches for teaching higher-order thinking processes merely sample those which can be derived from theory or purchased for classroom use:

CLASSROOM QUESTION CLASSIFICATION

Category Description (Part A)

Category Name	Expected Cognitive Activity	Key Concepts (terms)	Sample Phrases and Questions
1. REMEMBERING (KNOWLEDGE*)	Student recalls or recognizes information, ideas, and principles in the approximate form in which they were learned.	memory knowledge repetition description	1. "What did the book say about...?" 2. "Define...." 3. "List the three..." 4. "Who invented....?"
2. UNDERSTANDING (COMPREHENSION*)	Student translates, comprehends, or interprets information based on prior learning.	explanation comparison illustration	1. "Explain the..." 2. "What can you conclude...?" 3. "State in your own words..." 4. "What does the picture mean?" 5. "If it rains, then what?" 6. "What reasons or evidence...?"
3. SOLVING (APPLICATION*)	Student selects, transfers, and uses data and principles to complete a problem task with a minimum of direction.	solution application convergence	1. "If you know A and B, how could you determine ...?" 2. "What other possible reasons...?" 3. "What might they do with...?" 4. "What would happen, do you suppose, if...?"
4. ANALYZING (ANALYSIS*)	Student distinguishes, classifies, and relates the assumptions, hypotheses, evidence, conclusions, and structure of a statement or a question with an awareness of the thought processes he is using.	logic induction and deduction formal reasoning	1. "What was the author's purpose, bias, or prejudice...?" 2. "What must you know for that to be true?" 3. "What might they do with...?" 4. "What would happen, do you suppose, if...?"
5. CREATING (SYNTHESIS*)	Student originates, integrates, and combines ideas into a product, plan or proposal that is new to him.	divergence productive thinking novelty	1. "If no one else knew, how could you find out?" 2. "Can you develop a new way?" 3. "Make up..." 4. "What would you do if...?"
6. JUDGING (EVALUATION*)	Student appraises, assesses, or criticizes on a basis of specific standards and criteria (this does not include opinion unless standards are made explicit).	judgment selection	1. "Which policy will result in the greatest good for the greatest number?" 2. "For what reason would you favor...?" 3. "Which of the books would you consider of greatest value?" 4. "Evaluate the idea in terms of cost and common acceptance."

*Terms used in Bloom (1956)

Figure 1. Classroom Question Classification, Category Description, (Part A) (Courtesy Gary Manson and Ambrose Clegg, Jr., 1970).

Some General Descriptions:

Problem Solving - Problem solving is a goal-directed, multiple, trial-and-check approach to new situations and learning tasks, in which the individual makes choices, decisions, judgments, and critical analyses to reach a conclusion.

Decision Making - Decision Making involves the process of arriving at some inference or conclusion. May be either a perceptual or cognitive process. (See Glasser, 1969)

Discovery Learning - Discovery Learning is the process of acquiring new information or knowledge largely as a result of the learner's own efforts. (See Bruner, 1961)

Inquiry Learning - Inquiry Learning involves the process by which a student brings about his/her own learning by asking questions and using a variety of resources to find answers.

Directed Reading-Thinking Activity (DR-TA) - The DR-TA is an individual or group procedure that helps students set purposes for reading and comprehending material at both literal and higher-order cognitive levels of thinking. (See Stauffer, 1980; and Davidson, 1982)

In Figure 2, Costa (1983) compares several authors' models of human intellectual functioning. The model shows three phases of thought involved in intellectual processing. "Input of data from the senses and from memory; the processing of those data into meaningful relationships; and the output or application of those relationships to novel situations" (Costa, 1983, pp. 212-213).

Insert Figure 2 about here

Commercial/Published Materials:

Cognitive Research Trust (CoRT) Program (Cognitive Research Trust, Cambridge, England). The CoRT Thinking Program was developed by Edward de Bono and contains sixty relatively independent lessons that can be easily implemented without formal training. Program goals include: emphasizing thinking in its own curriculum area;

DATA INPUT PHASE	PROCESSING PHASE	OUTPUT PHASE	SOURCE
Internal and External Input	Central Processing	Output	Atkinson & Shiffrin, 1968
Participation and Awareness	Internalization	Dissemination	Bell & Steinaker, 1979
Knowledge	Comprehension Analysis Synthesis	Application Evaluation	Bloom, 1956
Descriptive	Interpretive	Evaluative	Eisner, 1979, pp. 203-213
Input	Elaboration	Output	Feuerstein, 1980, pp. 71-103
Fluency	Manipulation	Persistence	Foshay, 1979 pp. 93-113
Cognition and Memory	Evaluation	Convergent and Divergent Production	Guilford, 1967
Fact	Concept	Value	Harmin, 1973
Receiving	Responding Valuing Organizing	Characterizing	Krathwohl, 1964
Alertness	Information Processing	Action	Restak, 1979, p. 44
Learning	Integrating	Applying	Sexton & Poling, 1973, p. 7
Intuitive	Awareness	Function	Strasser, 1972, pp. 46-47
Intake Storage	Mediation	Action	Suchman, 1966, pp. 177-187
Concept Formation	Interpretation and Inference	Application of Principles	Taba, 1964, pp. 30-38
Detailed Observation Recall of Previous Knowledge	Comparison	Rule Generation Auto Criticism	Whimbey, 1976, pp. 116-138
Romance	Precision	Generalization	Whitehead, 1929, p. 29

Figure 2. A comparison of several authors' models of human intellectual functioning (Courtesy Arthur L. Costa, 1983).

regarding thinking as a skill that can be learned, improved, and practiced; regarding students as thinkers and providing a set of transferrable thinking tools which can be used in various situations. (See de Bono, 1976 1983; Tripp, 1977).

Instrumental Enrichment (I.E.) Curriculum Development Associates, Inc., Washington D.C.). Instrumental Enrichment was originally developed by Reuven Feuerstein for use with adolescents and adults in correcting deficient cognitive functions. At present, I.E. is used by numerous school districts and other institutions as a curriculum intervention program for developing thinking and learning skills. This paper-pencil intervention program requires professional training and dissemination by Curriculum Development Associates, Inc., Suite 414, 1211 Connecticut Ave., N.W., Washington D.C. 20036. (See Hobbs, 1980; Makler, 1980; Harth, 1982)

QUEST Program The QUEST Program (Questions to Upgrade and Encourage Student Thinking) focuses on the improvement of teacher questioning skills and improvement of student ability to ask and answer higher-order questions. (See Hughes, 1981)

S.O.I. Institute The S.O.I. materials and programs are an educational adaptation by Mary Meeker, of J. P. Guilford's Structure of Intellect (S.O.I.). S.O.I. testing and training diagnoses 26 thinking abilities so that intellectual disabilities can be identified, treated, and turned into strengths. (For information, contact Midwest Publications for an Introductory Packet or write: S.O.I. Institute, 214 Main St., El Segundo, CA 90245)

Thinking Skills (Midwest Publications) Midwest Publications offer a wide variety of materials for teaching thinking skills. Publications include: Basic Thinking Skills, Brain Stretchers, Critical Thinking, Figural Analogies, Inductive Thinking Skills, Mind Benders, Syllogisms, and many others stressing the higher-order thinking skills.

Other Sources:

Learning to Think Series
Science Research Associates

Lessons in Logic
Resources for the Gifted

Thinking Tool Kits
Resources for the Gifted

Think - Ins, An Approach to Relevant Curriculum Stressing Creative Thinking and Problem Solving
Creative Teaching Press, Inc.

Think Lab
Science Research Associates, Inc.

Think Tank Mind Development Program
Educational Media Limited

Evaluating the Higher-Order Thinking Skills

If growth in using higher-order thinking processes is to be evaluated, then current assessment devices need to be reconceptualized (Eisner, 1979). These tests which evaluate the higher-order processes would indicate to students that the higher-order skills are valued as educational goals. Benjamin Bloom (1978) states that "the instruments for educational measurement (external examinations, teachers' tests and final examinations, standardized tests, etc. have always had a controlling force on what was taught and, even more, on what was learned by students" (p. 68). In terms of testing thinking processes, Bloom (1978) further states that:

It is evident that students attempt to learn the skills, abilities, and subject content that they believe will be emphasized in the evaluation procedures they will be judged on. If they believe this is largely rote information, they will study and prepare accordingly. If they believe they will be judged on their ability to use the ideas and processes in new situations, they will learn and prepare to demonstrate such abilities (p. 71).

In effect, what we test, is what we get. At present, methods of diagnosis do not indicate which thinking or learning skills are performed well or poorly. Thus, it is evident, that educational evaluation needs to focus more on process assessment and perhaps less on product assessment (Sternberg, 1981).

Effective evaluation of the higher-order thinking skills involves critical analyses of teacher-made and commercially published tests. Educators involved in the informal analysis of various assessment devices and the types of questions included in them, can discover whether the tests emphasize more factual and mechanical learnings than processes involving analysis, synthesis, and evaluation. With classroom assessment devices, teachers must analyze and change the types of questions presented in both the tests and instructional materials. If this is done wisely, questions involving higher-order processes will also involve answers that require pertinent facts and details to support hypotheses and conclusions. At best, it may not be necessary to include questions specifically designed for recall of factual information. Ideally, "individual cognitive maps displaying deficiencies and peaks in intellectual abilities should replace test scores. Test should be learning experiences starting with real and concrete problems and advancing to more abstract, complex tasks" (Costa, 1981, p. 31). At this time, it is not practical to anticipate that assessment devices, particularly those that are standardized, will become completely reconceptualized or restructured. However, it is practical, as professional educators, to critically analyze tests by:

- 1) becoming aware of tests that overemphasize lower-order cognitive abilities; 2) becoming actively involved in the selection of appropriate commercially produced tests; and 3) formulating classroom tests that assess the higher-order thinking processes. (To assist in this type of critical test analysis, refer to Bloom, Madaus, and Hastings, Evaluation to Improve Learning, 1981).

Implementing Thinking Skill Instruction

Future-thinking, societal needs, and the nature of the learning process and the learner, all demand development of the higher-order thinking abilities. Teaching the learner to think as well as think-about-thinking will need to be viewed as a priority goal in the public school curriculum. At present, "little progress in developing these higher processes can be expected until teachers develop the necessary capabilities and are helped to find ways of teaching higher intellectual processes to the students in their classes" (Bloom, 1981). It is evident that thinking skill instruction is a necessary element in the public school curriculum and that professional educators have a variety of options to consider concerning the process of implementing higher-order thinking skill instruction: One, is that they assume the higher-order processes are being developed under the existing educational system; Two, simply valueing and articulating that the development of higher-order skills is a necessary educational goal; Three, facilitating local awareness of the articulated goal; Four, Creating in-service programs that indirectly integrate higher-order skill instruction into classrooms; and Five, expand- ind in-service to include curriculum development, plans for implementation, training, and follow-up of a thinking skill program.

Other decisions concerning the implementation of thinking skill instruction contemplate whether: Commercial materials can and need be purchased; thinking skill instruction be integrated into the existing curriculum or whether it should function as a curriculum and instruction area in its own right; if thinking skill instruction should focus on a specific sequence of skills; or numerous other concerns. With

complex and realistic decisions set before you as examples, ask yourself, as an adult and professional educator who is constantly faced with rapid changes and situations requiring relearning, adapting, decision making, problem solving, discovering, divergent thinking, critical thinking, logical reasoning, applying, analyzing, synthesizing, evaluating, and other higher-order thinking processes, what is the answer? Think about it.

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